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Effect of environmental temperature and inoculants on the fermentation of alfalfa and forage sorghum silages

Abstract

The inoculants, TriLac® and Ecosyl® increased the rate and efficiency of the ensiling process in both high (50%) and low (32.5%) dry matter alfalfa, regardless of temperature. In both alfalfa trials, the inoculated silages had significantly lower pH, acetic acid, ethanol, and ammonia-nitrogen values and higher lactic acid values than their control counterparts. The inoculants worked equally well when fermentation was at 60 or 90 F. Although similar effects were obtained with forage sorghum, the differences were not as pronounced as those for the alfalfa silages.

Keywords

Kansas Agricultural Experiment Station contribution; no. 88-363-S; Cattlemen's Day, 1988; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 539; Beef; Alfalfa; Sorghum silage; TriLac®; Ecosyl®

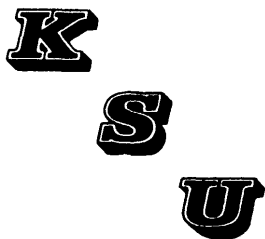
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Authors

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Effect of Environmental Temperature and Inoculants on the Fermentation of Alfalfa and Forage Sorghum Silages¹

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Summary

The inoculants, TriLac[®] and Ecosyl[®] increased the rate and efficiency of the ensiling process in both high (50%) and low (32.5%) dry matter alfalfa, regardless of temperature. In both alfalfa trials, the inoculated silages had significantly lower pH, acetic acid, ethanol, and ammonia-nitrogen values and higher lactic acid values than their control counterparts. The inoculants worked equally well when fermentation was at 60 or 90 F. Although similar effects were obtained with forage sorghum, the differences were not as pronounced as those for the alfalfa silages.

Introduction

Silage-making in Kansas begins in May with crops like alfalfa and winter cereals and ends in November with late-season forage sorghums. During these 7 months, minimum and maximum daytime temperatures will range from less than 32 F to over 100 F. How do the air temperature and the temperature of harvested forage as it enters the silo affect the ensiling process? Results from the last 2 years using alfalfa and forage sorghum (KAES Reports of Progress 494 and 514) indicated that initial fermentation was delayed by a cool temperature and that a warm initial temperature produced silages with lower pH values and higher acid contents. In addition, a silage inoculant generally increased the fermentation rate, particularly with alfalfa when the fermentation temperature was cool.

Our objective was to further document the effect of fermentation temperatures and inoculants on the rate and efficiency of fermentation in alfalfa and forage sorghum.

Experimental Procedures

The PVC laboratory silo used in these trials, the treatment methods, and the silo-filling techniques were similar to those described in the article on page 137 of this report. The inoculants were applied in liquid form. TriLac contains Lactobacillus plantarum and Pedicoccus cerevisiae and supplied 2.54×10^5 , 2.86×10^5 , and 2.90×10^5 colony-forming units. (CFU) of bacteria per gram of crop in Trials 1, 2, and 3, respectively. Ecosyl contains Lactobacillus plantarum and supplied 2.90×10^5 CFU per gram of crop in Trial 3. Chemical composition and microorganism profile of the pre-ensiled crops are presented in Table 40.1.

¹

Partial financial assistance was provided by Quali-Tech, Inc., Chaska, Minnesota and C-I-L, Inc., London, Ontario, Canada.

Trial 1. Silages was made from late-dough stage, post-frost, hybrid forage sorghum (DeKalb 25E) on October 8, 1986. The direct-cut material contained 29.0% dry matter (DM) and was approximately 70 to 75 F when ensiled. Four treatments were compared: (1) control (no inoculant), with the laboratory silos stored at 60 F (control-60); (2) control, with silos stored at 90 F (control-90); (3) TriLac-treated, with silos stored at 60 F (TriLac-60); and (4) TriLac-treated, with silos stored at 90 F (TriLac-90). Eighteen laboratory silos were filled for each treatment, with three silos per treatment opened at 12, 24, and 48 hours and 4, 7, and 90 days post-filling.

Trial 2. Silage was made from fifth cutting, post-frost alfalfa on October 16, 1986. The 24-hr wilted material contained 51.0% DM and was 75 F when ensiled. The treatments and opening times were the same as those described in Trial 1.

Trial 3. Silage was made from second cutting alfalfa on June 19, 1987. The 3- to 4-hr wilted material contained 34.0% DM and was 80 F when ensiled. Both TriLac and Ecosyl were included as treatments at 60 and 90 F.

Results and Discussion

Presented in Figures 40.1 to 40.6 are temperature and inoculant effects on silage fermentation dynamics during the first 7 days post-filling in the three trials. Silage fermentation results for the 90-day silages is shown in Table 40.2.

In Trial 1, both 90 F forage sorghum silages had sharply lower pH values and higher lactic acid contents at 24 hours than the two 60 F silages (Figures 40.1 and 40.2). Beginning at 4 days post-filling, the TriLac-60 silage had lower pH and higher lactic acid values than the control-90 silage. The 90-day, TriLac-90 and TriLac-60 silages had lower pH, acetic acid, ethanol, and ammonia-nitrogen and higher lactic acid values ($P < .05$) than the control-90 and control-60 silages (Table 40.2).

In Trial 2, the control-90 and control-60 alfalfas fermented very slowly and were still above pH 5.40 and below 3.2% lactic acid at 7 days post-filling (Figures 40.3 and 40.4). In contrast, the inoculated silages had significantly lower pH and higher lactic acid values than the control-90 silage, beginning at 48 hours for TriLac-90 and 7 days for TriLac-60 silages. The 90-day, TriLac-90 and TriLac-60 silages had significantly lower pH, acetic acid, ethanol, and ammonia-nitrogen and higher lactic acid values than the two control silages (Table 40.2).

The temperature and inoculant effects on fermentation dynamics and 90-day chemical composition of the alfalfa silages in Trial 3 were nearly identical to those obtained in Trial 2 (Figures 40.5 and 40.6 and Table 40.2). Both inoculants, TriLac and Ecosyl, increased the rate and efficiency of silage fermentation over the control.

Table 40.1. Chemical Composition and Microorganism Profile of the Pre-ensiled Crops in Trials 1, 2, and 3

Item	DeKalb 25E	Alfalfa	
	Trial 1 1986	Trial 2 1986	Trial 3 1987
Dry Matter, %	29.0	51.0	32.5
pH	5.85	6.1	5.95
Water Soluble Carbohydrates ¹	7.25	6.2	5.4
Crude Protein ²	7.2	22.0	20.7
Buffer Capacity ³	20.2 ⁷	59.5 ⁷	52.6 ⁷
Mesophilic Bacteria ³	8.9 x 10 ⁴	7.2 x 10 ⁴	3.8 x 10 ⁵
Lactic Acid Bacteria ³	6.0 x 10 ⁴	6.8 x 10 ³	6.2 x 10 ³
Yeasts and Molds	1.3 x 10 ⁴	3.4 x 10 ³	7.0 x 10 ³

¹ Expressed as a % of the crop dry matter.

² Milliequivalents NaOH per 100 grams of crop DM required to raise the pH of the fresh material to 6.0.

³ Colony-forming units per gram of crop.

Table 40.2. Chemical Analyses of the 90-day Silages in the Three Trials

Crop, and Dry Treatment Matter		p H	Lactic Acid	Acetic Acid	Ethanol	NH ₃ -N
		%	-----% of the Silage DM-----			
<u>Trial 1: Forage Sorghum</u>						
Control-60	28.5	3.92 ^b	5.66 ^b	1.45 ^b	.304 ^b	.043
TriLac-60	28.8	3.87 ^a	6.42 ^a	.96 ^a	.231 ^a	.029
Control-90	28.5	3.98 ^c	4.99 ^a	1.34 ^b	.345 ^c	.050
TriLac-90	28.5	3.88 ^a	6.53 ^a	.76 ^a	.270 ^a	.032
<u>Trial 2: Alfalfa</u>						
Control-60	49.2	4.82 ^b	6.55 ^b	1.94 ^c	.272 ^c	.205 ^b
TriLac-60	49.8	4.34 ^a	9.31 ^a	1.12 ^a	.095 ^a	.133 ^a
Control-90	50.1	4.97 ^c	6.05 ^b	1.41 ^b	.170 ^b	.217 ^b
TriLac-90	50.5	4.43 ^a	9.99 ^a	1.00 ^a	.089 ^a	.130 ^a
<u>Trial 3: Alfalfa</u>						
Control-60	33.1	4.59 ^c	3.54 ^b	3.78 ^d	.322 ^b	.269 ^{ab}
TriLac-60	34.1	4.32 ^a	6.44 ^a	2.08 ^a	.104 ^a	.192 ^a
Ecosyl-60	33.6	4.38 ^a	6.23 ^a	2.71 ^b	.126 ^a	.200 ^a
Control-90	33.4	4.58 ^a	4.41 ^b	3.23 ^c	.400 ^b	.312 ^b
TriLac-90	34.1	4.45 ^b	6.43 ^a	2.11 ^a	.116 ^a	.245 ^{ab}
Ecosyl-90	33.0	4.46 ^b	6.25 ^a	2.64 ^b	.171 ^a	.234 ^{ab}

^{a b c d} Values in the same column within a trial with different superscripts differ (P<.05).

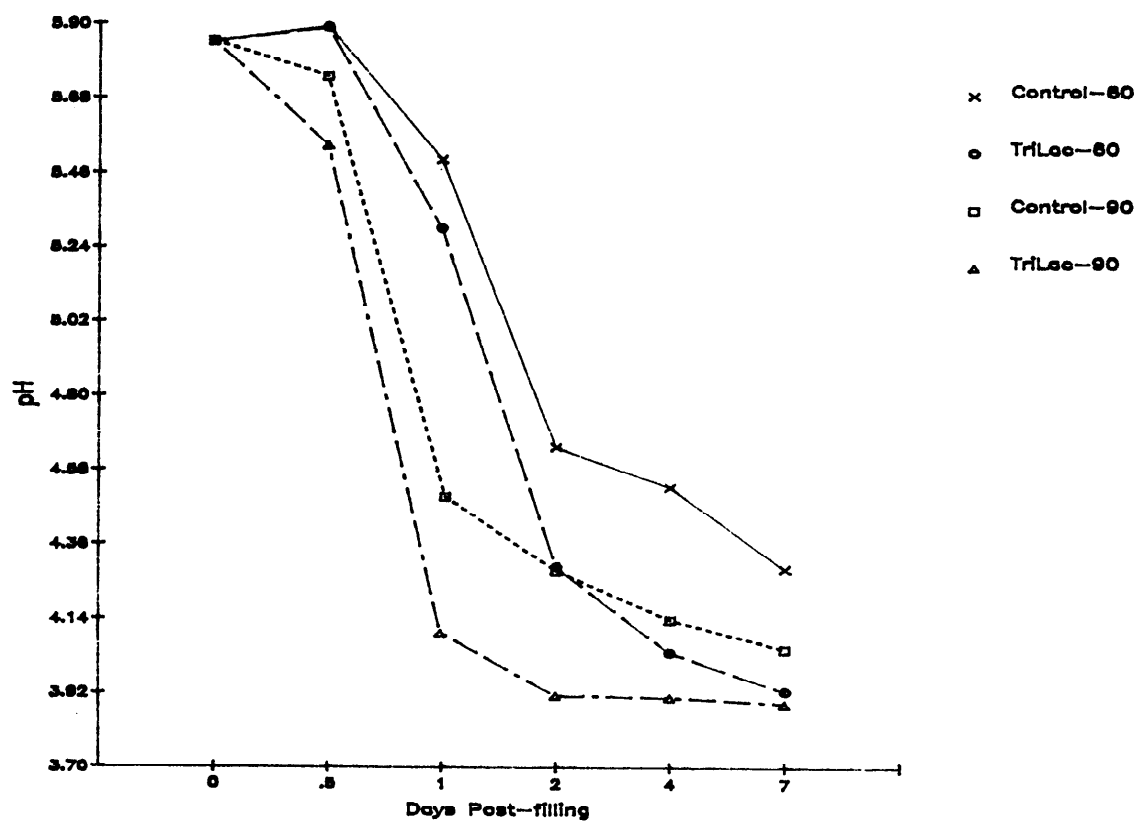


Figure 40.1. pH over Time for the Forage Sorghum Silages in Trial 1

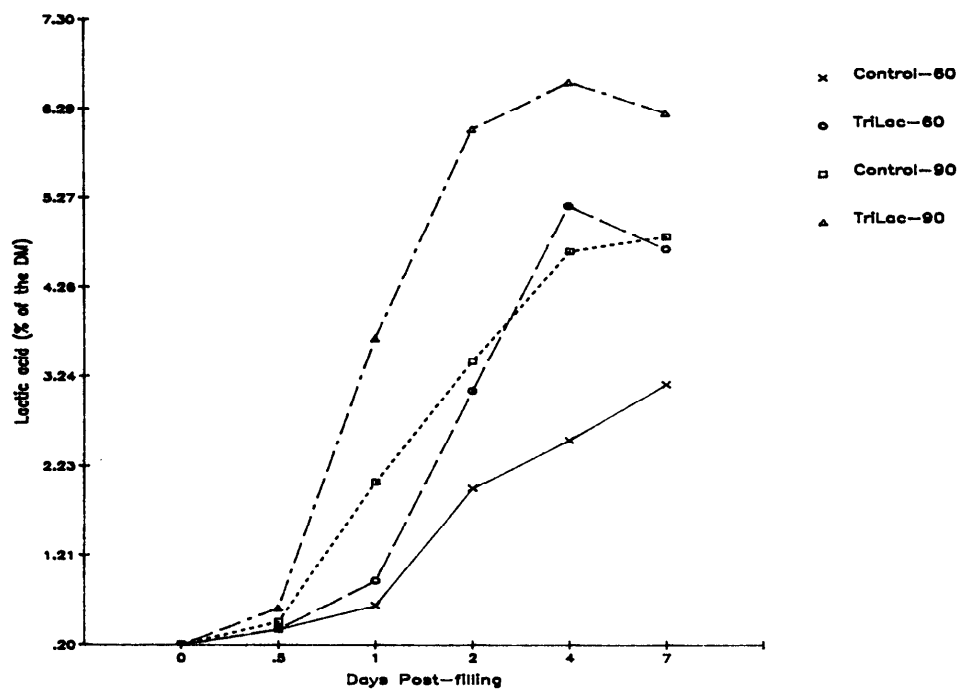


Figure 40.2. Lactic Acid over Time for the Forage Sorghum Silages in Trial 1

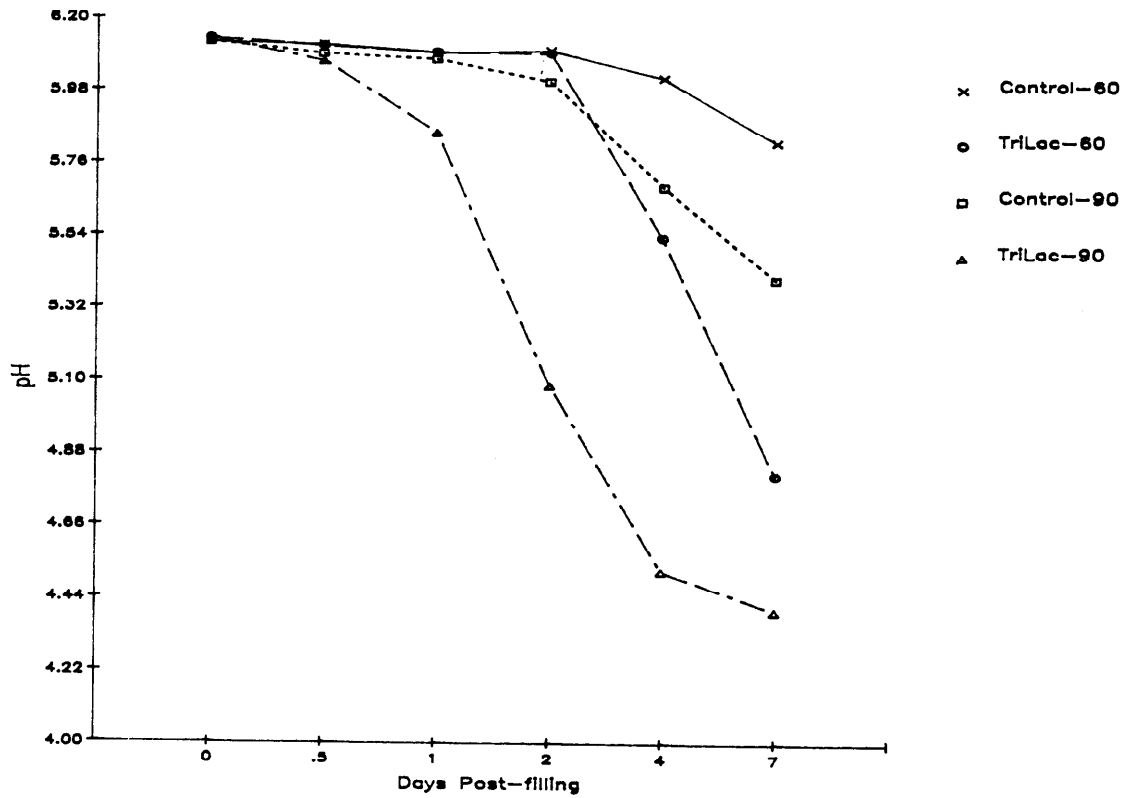


Figure 40.3. pH over Time for the Alfalfa Silages in Trial 2

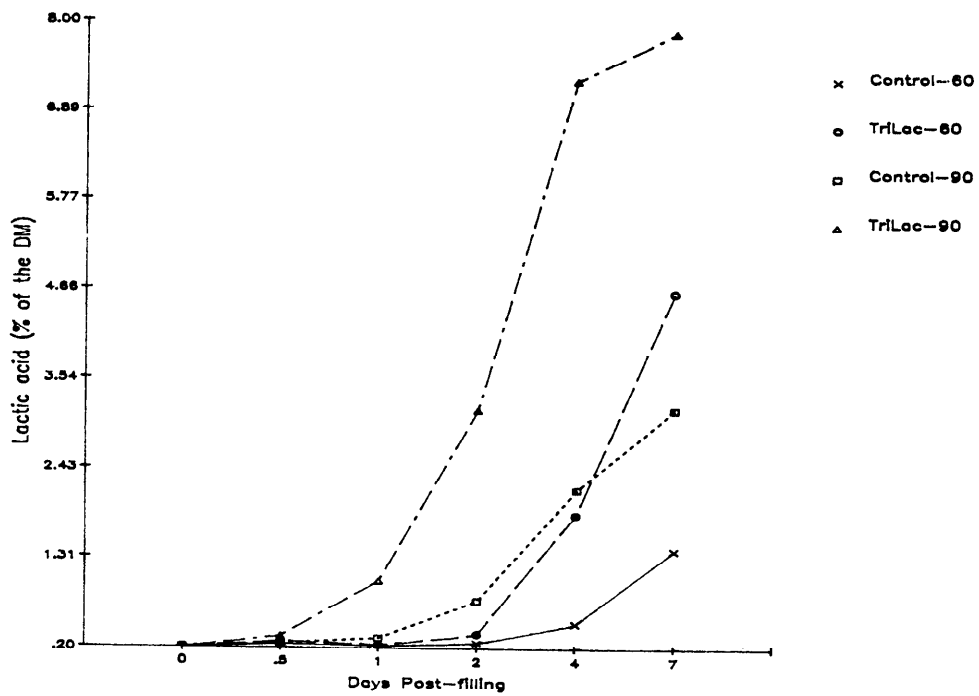


Figure 40.4. Lactic Acid over Time for the Alfalfa Silages in Trial 2

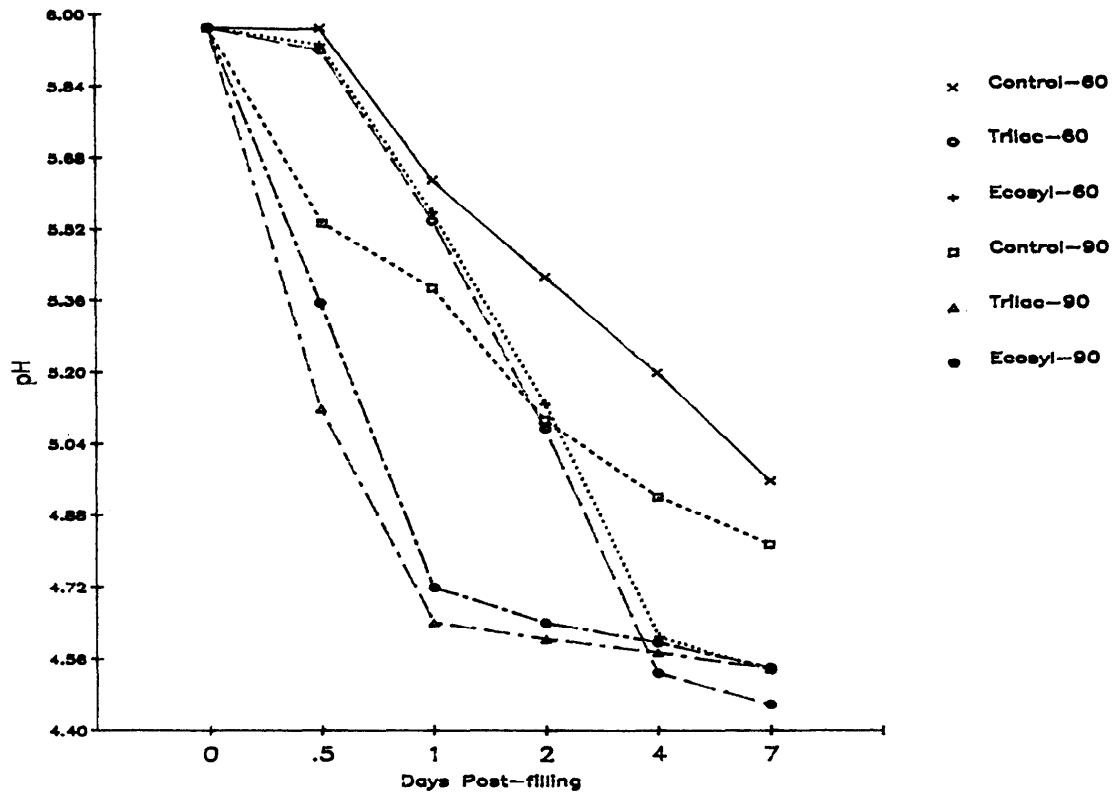


Figure 40.5. pH over Time for the Alfalfa Silages in Trial 3

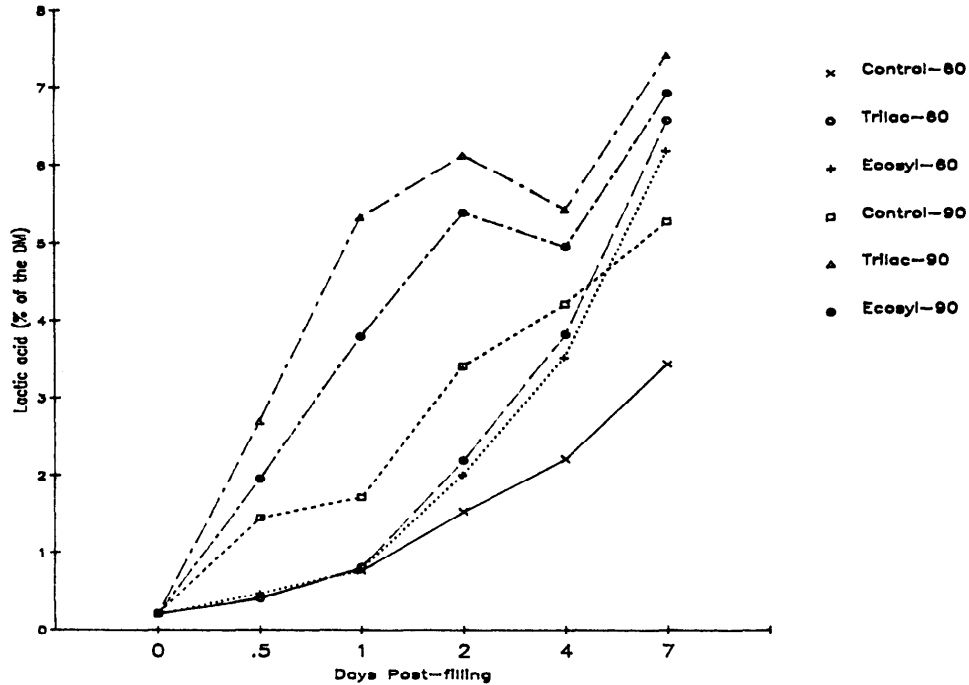


Figure 40.6. Lactic Acid over Time for the Alfalfa Silages in Trial 3